

# Recent Atmospheric Rivers

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Center for Western Weather and Water Extremes  
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Acknowledgments to  
Chad Hecht and Julie Kalansky

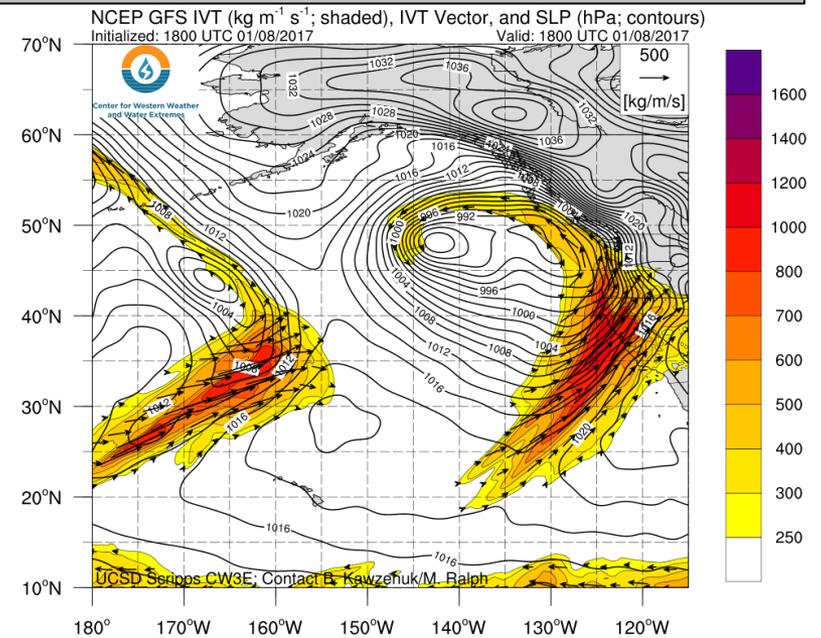
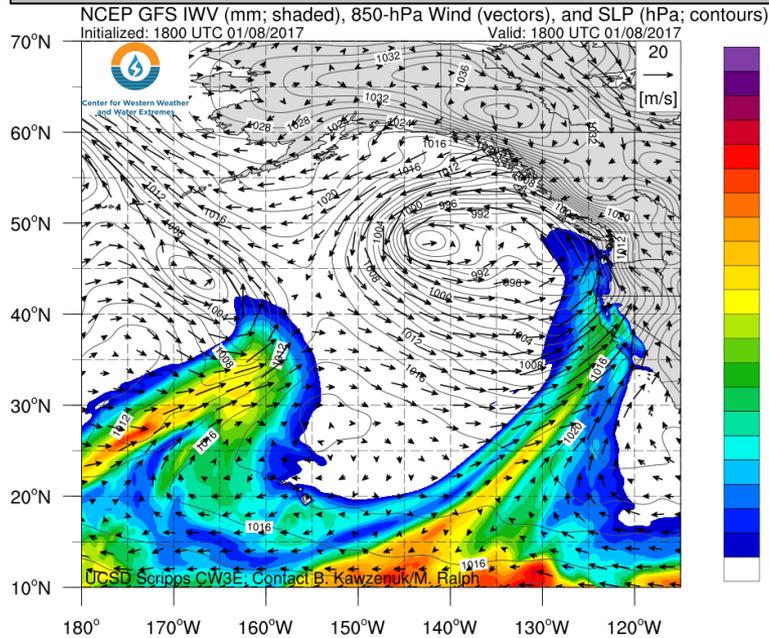
Southern California NIDIS Meeting  
Thursday February 9<sup>th</sup>, 2017  
Scripps Institution of Oceanography, La Jolla, California



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# Atmospheric Rivers



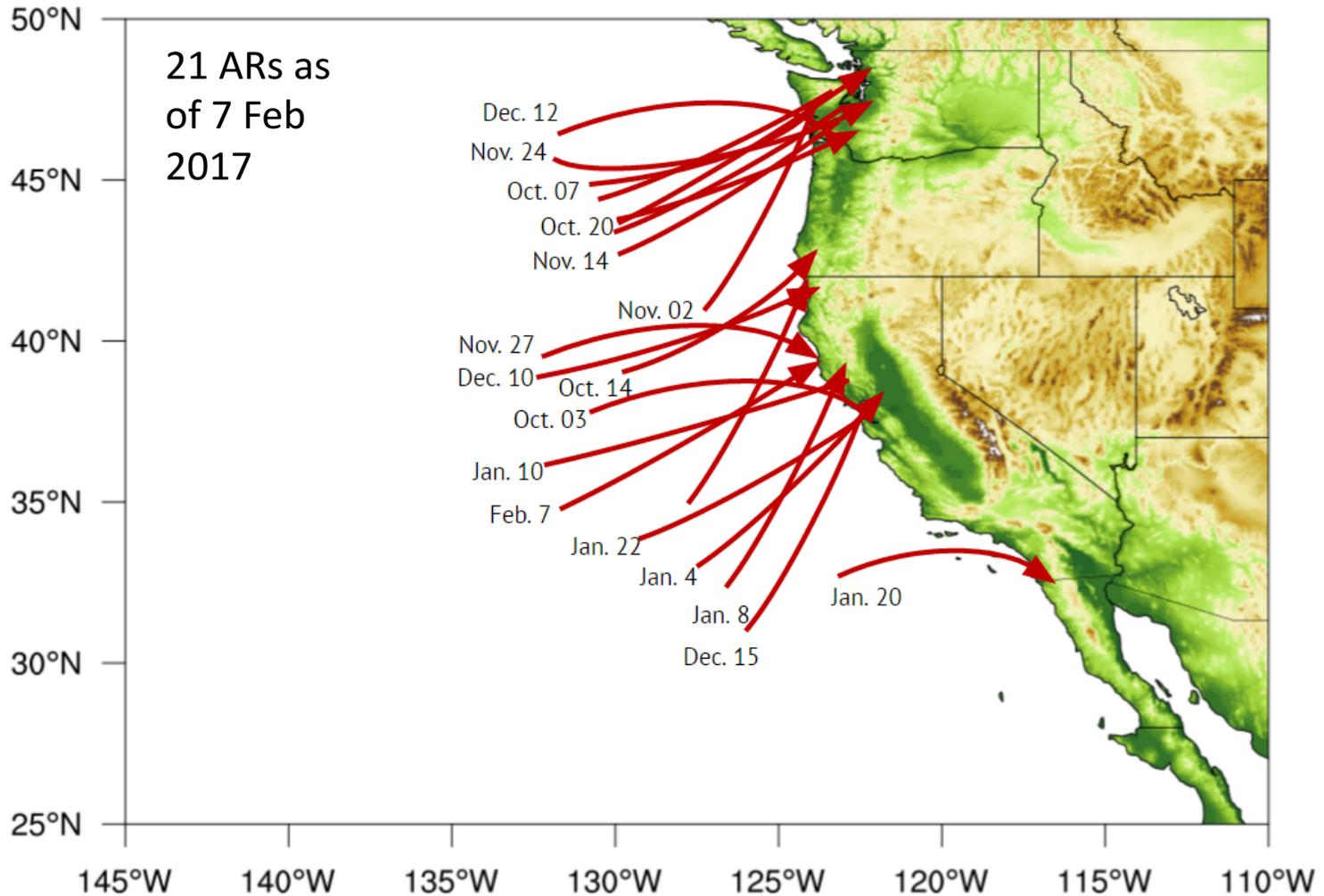
- ARs are characterized as long (>2000 km) and narrow (500–1000 km) corridors of enhanced vertically integrated water vapor (IWV; Left Image) and integrated water vapor transport (IVT; Right Image)
- Characterization of AR Strength:
  - Weak AR: IVT 250–500  $\text{kg m}^{-1} \text{s}^{-1}$
  - Moderate AR: IVT 500–750  $\text{kg m}^{-1} \text{s}^{-1}$
  - Strong AR: IVT 750–1000  $\text{kg m}^{-1} \text{s}^{-1}$
  - Extreme AR: IVT >1000  $\text{kg m}^{-1} \text{s}^{-1}$



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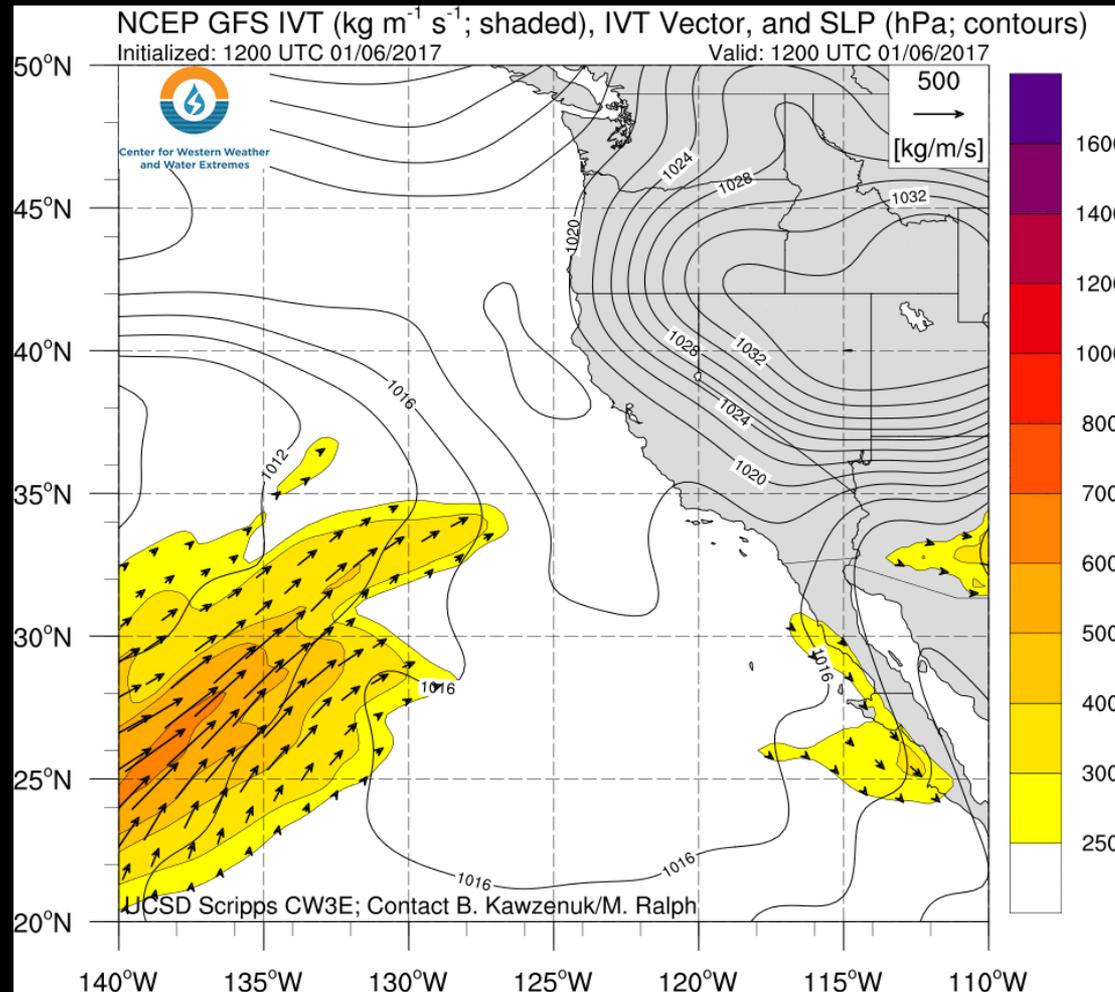
# Water Year 2017 ARs



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# 6–12 January 2017 ARs



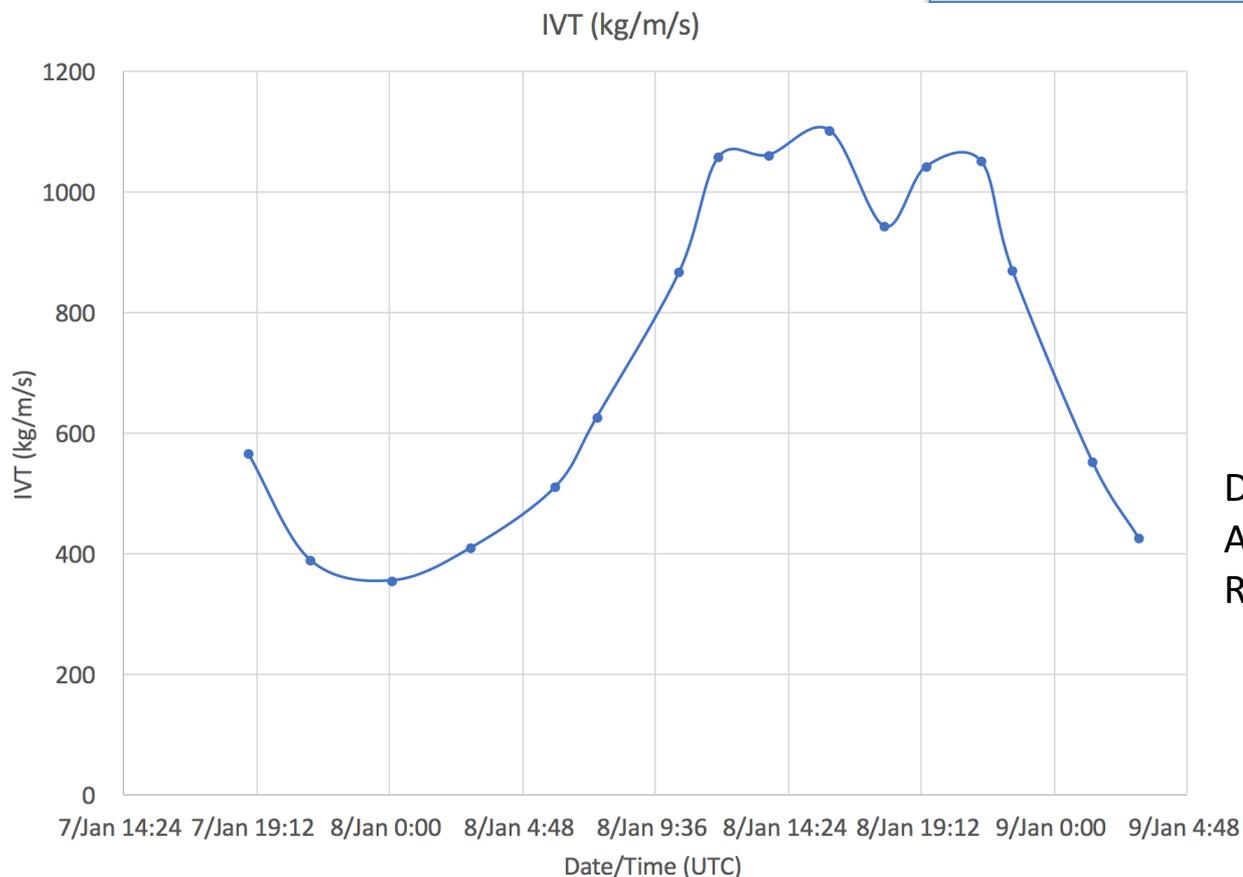
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# CW3E-FIRO Observations on 8 Jan 2017

- Deployed earlier than planned
- Radiosondes observed >1000 kg/m s IVT

Date/Time (UTC)	IWV (cm)	IVT (kg/m/s)
1/7/17 18:54	2.69	565.5
1/7/17 21:09	2.57	388.1
1/8/17 0:07	2.42	354.3
1/8/17 2:56	2.79	407.9
1/8/17 5:59	3.28	508.7
1/8/17 7:30	3.2	625.4
1/8/17 10:28	3.48	865.4
1/8/17 11:53	3.74	1056.1
1/8/17 13:42	3.65	1060.4
1/8/17 15:53	3.49	1101.9
	3.23	941.8
	3.48	1040.9
	3.26	1050.1
	3	869.4
	2.65	550.3
	2.33	425.2



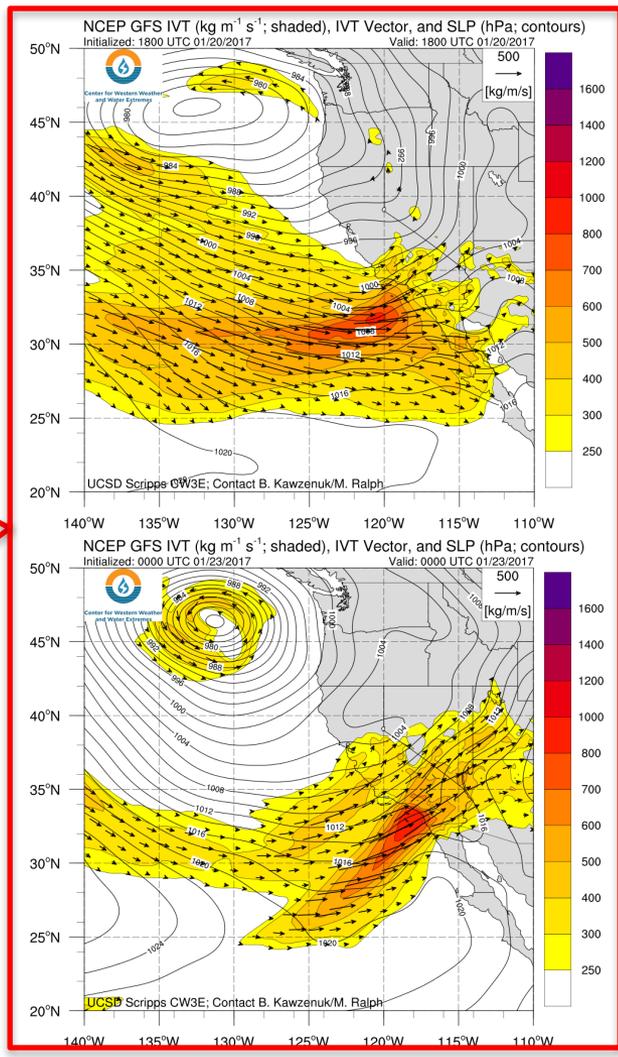
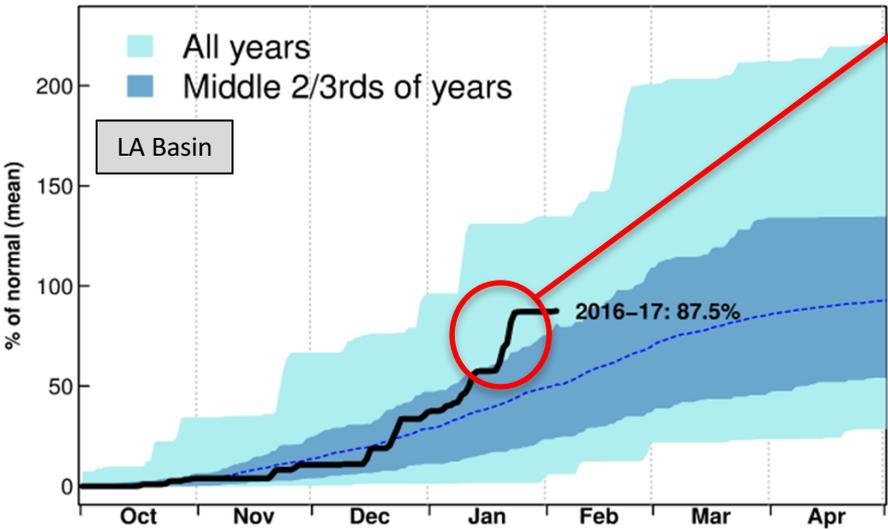
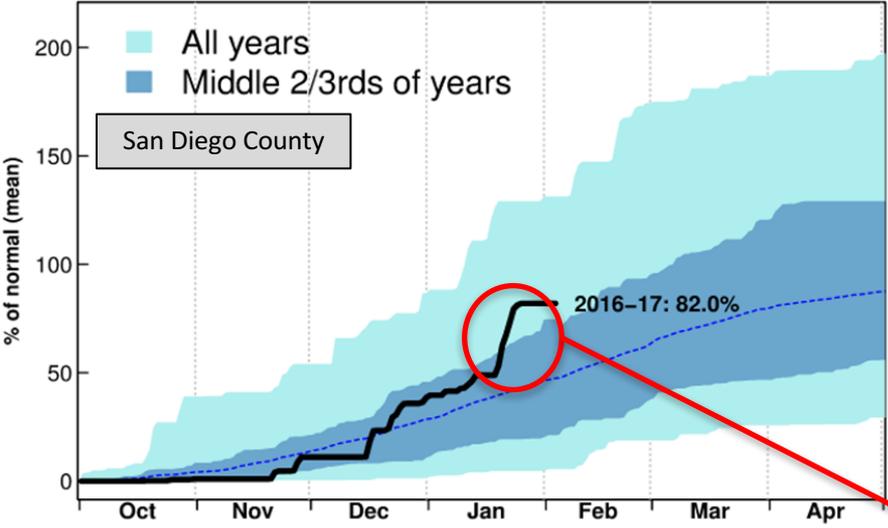
Data collected by  
 Anna Wilson (PostDoc) and  
 Reuben Demirdjian (Grad student)



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# WY to Date Compared to All WYs



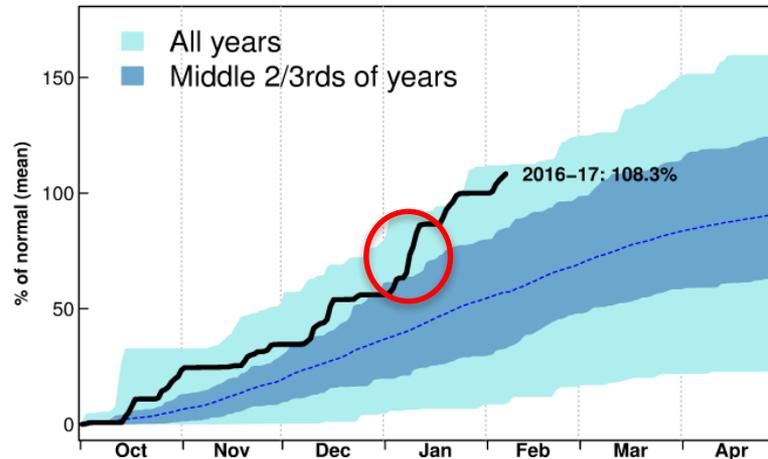
Between 20 and 24 January, San Diego County and the LA basin experienced an increase of ~30% of normal total WY precipitation due to two separate ARs impacting the region



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# Northern Sierra 8-Station Index



Current:	82.4%	1-day $\Delta$ :	7.01%	2-day $\Delta$ :	11.08%	3-day $\Delta$ :	19.08%
-----							
	(2014/01/10)						
Rec_low:	6.3%	50-ptile:	0.37%	50-ptile:	0.66%	50-ptile:	1.01%
Typ_low:	24.0%	90-ptile:	2.69%	90-ptile:	4.30%	90-ptile:	5.98%
Mean:	42.0%	95-ptile:	3.63%	95-ptile:	6.17%	95-ptile:	8.09%
Typ_high:	64.8%	99-ptile:	6.20%	99-ptile:	9.98%	99-ptile:	12.84%
Rec_high:	91.8%	Record:	13.57%	Record:	20.88%	Record:	27.32%
	(1997/01/10)		(1964/12/22)		(1964/12/23)		(1964/12/23)

- The Northern Sierra 8-station index experienced a three day percent of normal total WY change of 19.08% from 8 to 10 January 2017 due to two consecutive landfalling ARs
- 19.08% is well within the 99<sup>th</sup> percentile for all WYs



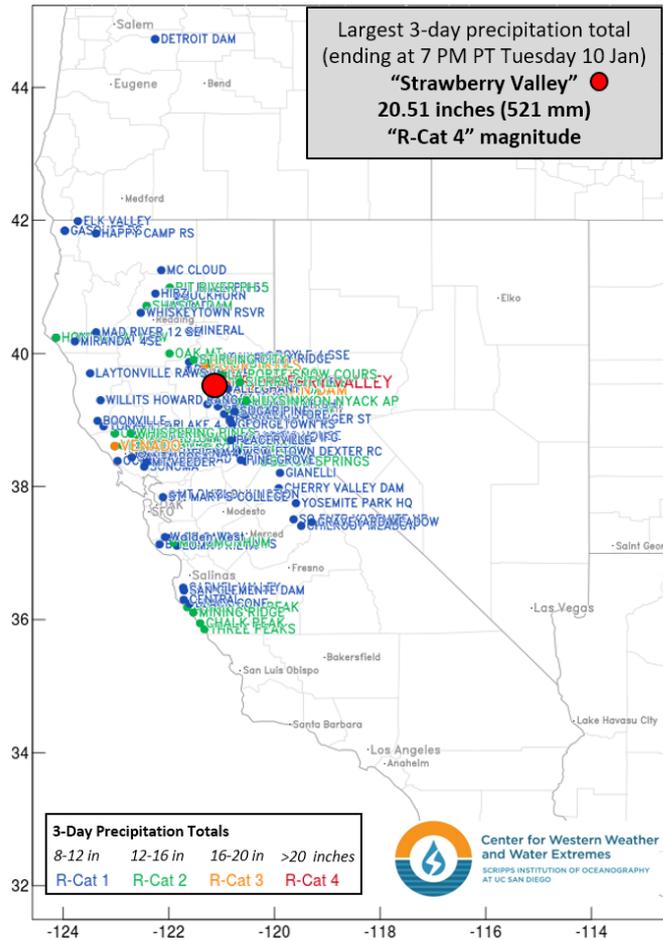
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# R-Cat Extreme Precipitation

CW3E R-Cat Extreme Precipitation Event Alert

R-Cat report produced 2017/01/11 04:49



Rainfall Category (R-Cat) was developed to identify and compare extreme precipitation using 3-day precipitation accumulations from rain gauges across the U.S.

**R-Cat 1:** 200-299 mm (roughly 8-12 inches) / 3 days

**R-Cat 2:** 300-399 mm (roughly 12-16 inches) / 3 days

**R-Cat 3:** 400-499 mm (roughly 16-20 inches) / 3 days

**R-Cat 4:** >500 mm (more than roughly 20 inches) / 3 days

From 7 PM PST 8 to 7 PM PST 10 January, the Strawberry Valley rain gauge in the Northern Sierras experienced an R-Cat 4 magnitude event with 20.51 inches (521 mm) of precipitation

To subscribe to this automated CW3E R-Cat Extreme Precipitation Alert via email: just email a message with subject "subscribe" to [rcatalert@cirrus.ucsd.edu](mailto:rcatalert@cirrus.ucsd.edu).

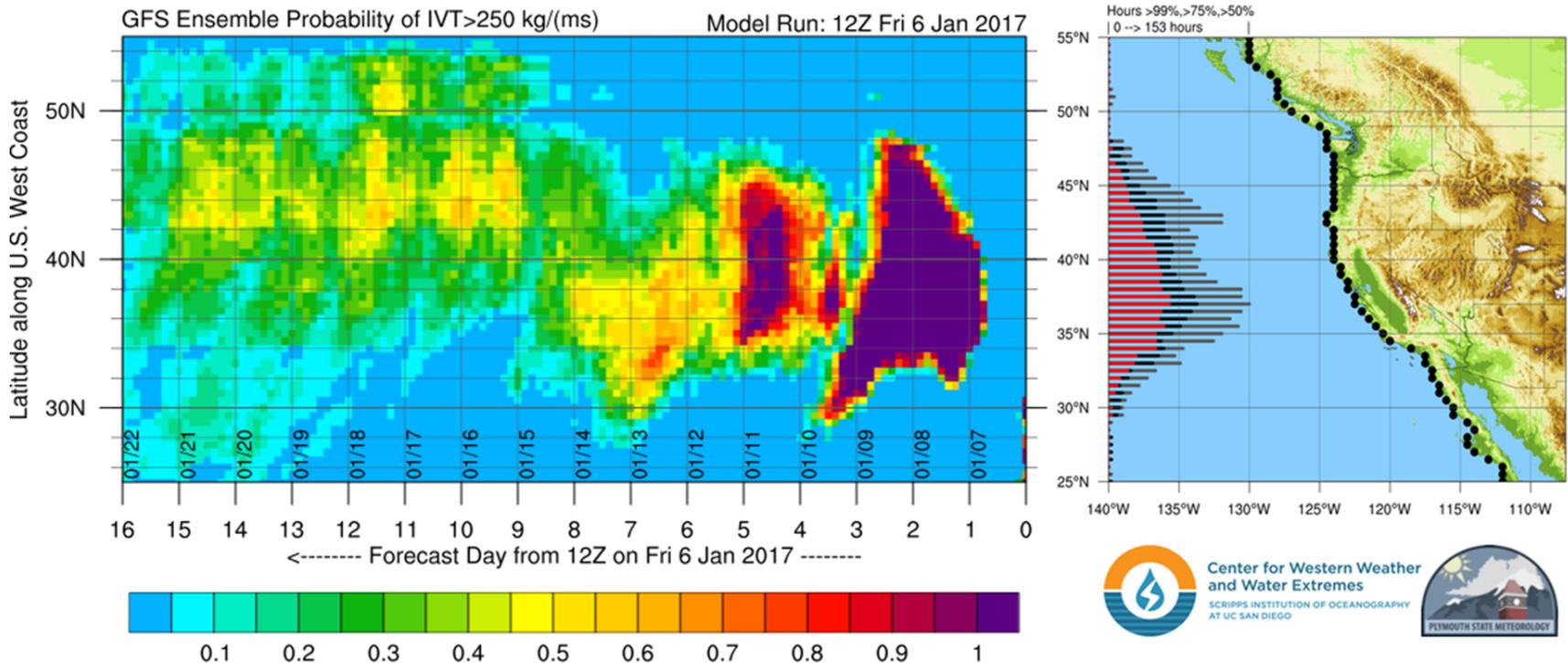


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Ralph and Dettinger 2012

# Probabilistic Forecast Products



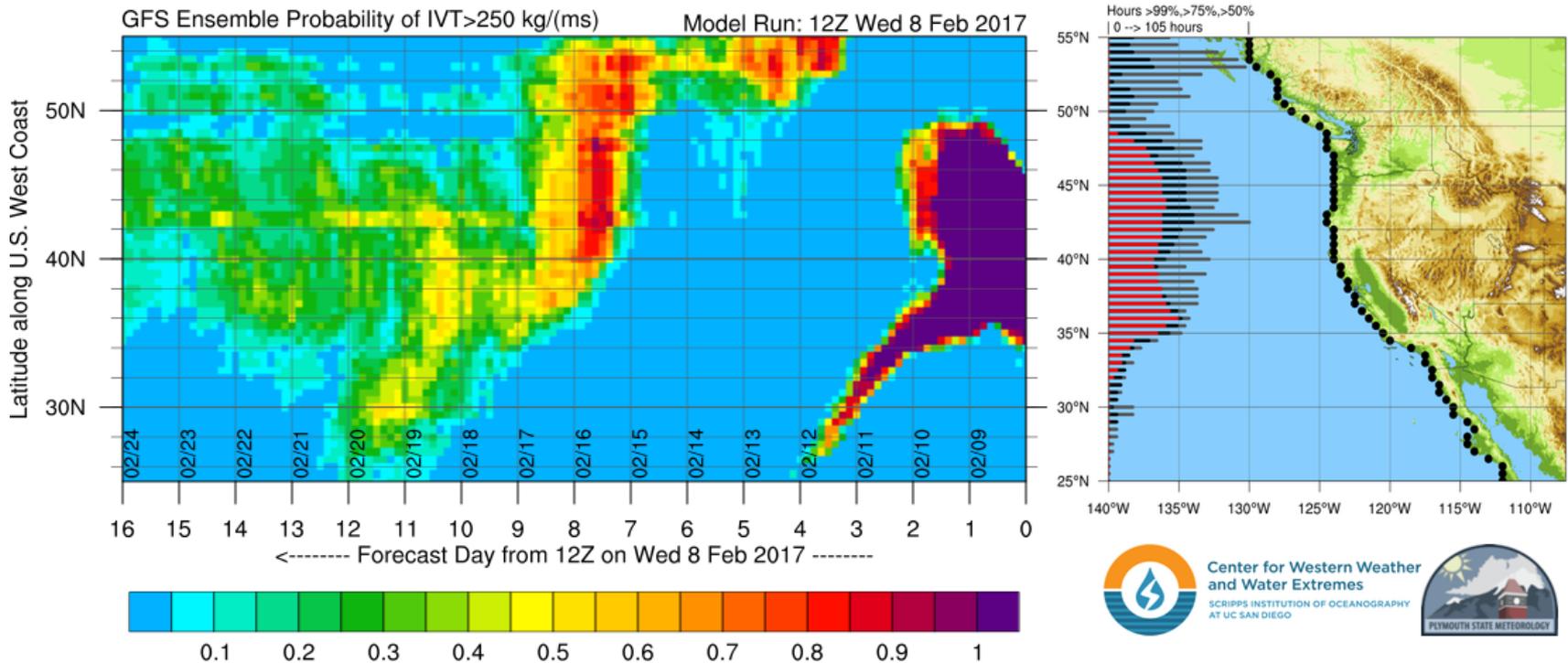
- Illustrates the probability (on scale of 0–1) of AR conditions ( $IVT > 250 \text{ kg m}^{-1} \text{ s}^{-1}$ ) at coastal locations
- In this example, there is high probability (values  $\sim 1$ ) of at least AR conditions along majority of the West Coast between 7 and 10 January 2017
- High uncertainty of AR conditions in extended forecast (beyond 5 days)



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# Probabilistic Forecast as of 4 AM Wed



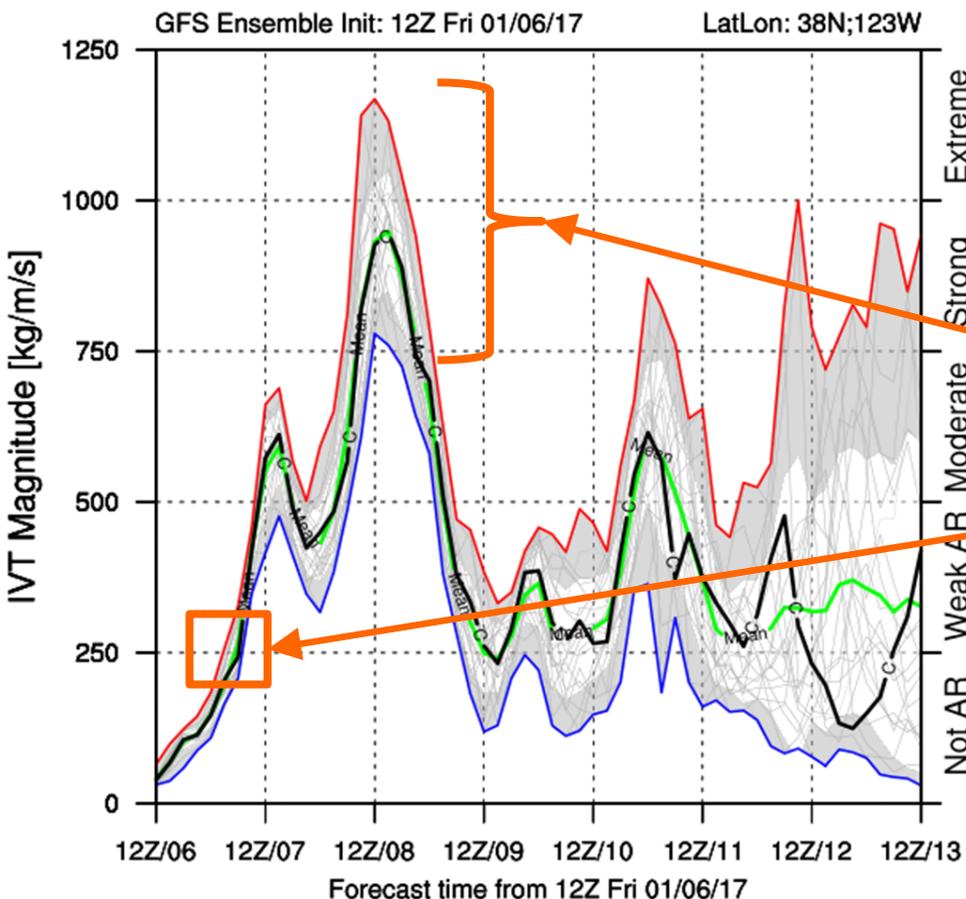
- High Probability of AR conditions lasting over 24 hours in Northern CA, OR, and WA
- Southward propagation of AR evident
- Weak AR conditions (IVT 250–500 kg m<sup>-1</sup> s<sup>-1</sup>) lasting 6 – 12 hrs over Southern CA



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# IVT Plume Forecast Product



- Illustrates the uncertainty in onset, magnitude, and duration of AR conditions between 21 ensemble forecasts

## Magnitude of AR

- Maximum possible IVT  $\sim 1150 \text{ kg m}^{-1} \text{ s}^{-1}$
- Mean IVT  $\sim 940 \text{ kg m}^{-1} \text{ s}^{-1}$
- Minimum possible IVT  $\sim 800 \text{ kg m}^{-1} \text{ s}^{-1}$
- Uncertainty  $\sim \pm 20\%$

- High confidence in onset of AR conditions

- Large uncertainty in extended forecast

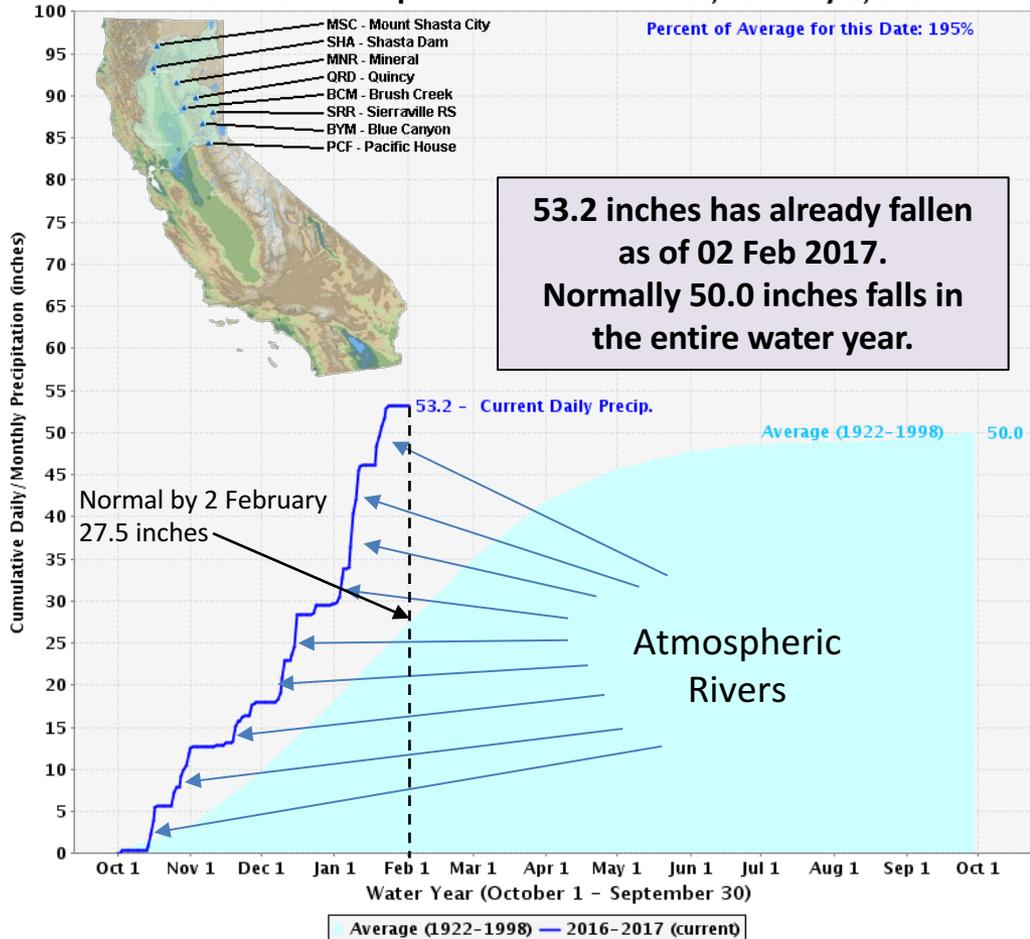


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# Northern Sierra 8-Station Index

Northern Sierra Precipitation: 8-Station Index, February 2, 2017



As of 02 February 2017, as much precipitation has already fallen as normally falls through the entire water year (ending 30 Sept).

In only two previous winters has this happened earlier in the year. In 1956 and 1997, both years with extreme flooding.

2017 (53.2") is in third place behind 1997 (58.2") and 1956 (54.5"). Both had major floods (New Year's 1997 and Dec 1955). December 1955 is the largest December total on the 8 station index at 30.83". Water Year 1997 recorded 47.84" in December and January combined.  
*Mike Anderson, California State Climatologist.*



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# Backup



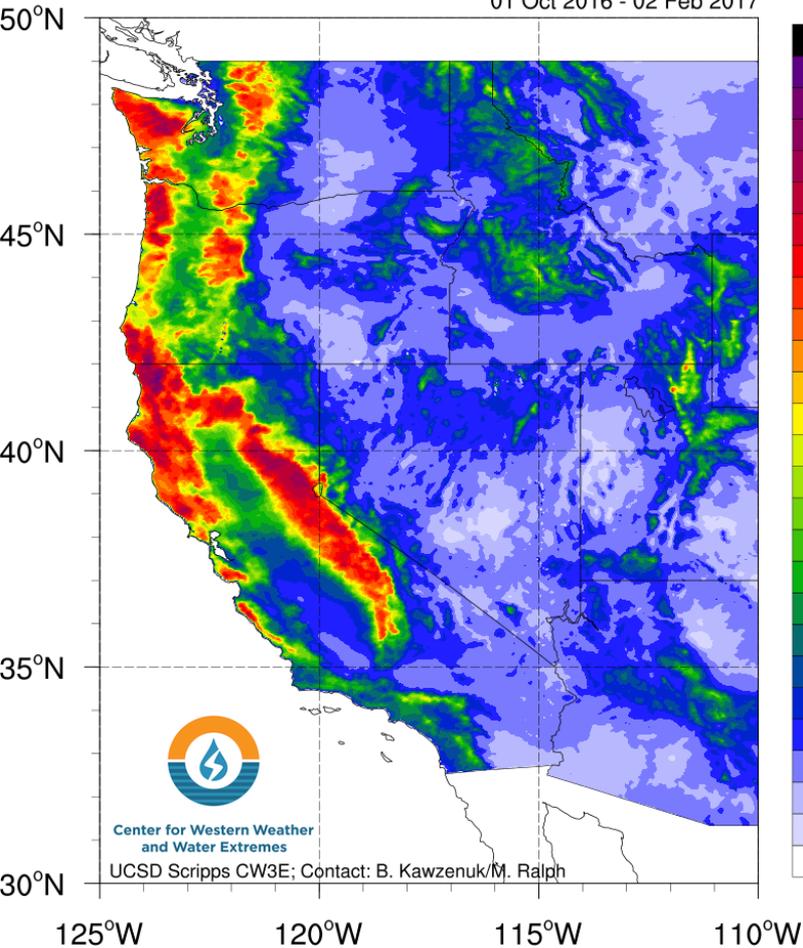
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# Water Year Precipitation to Date

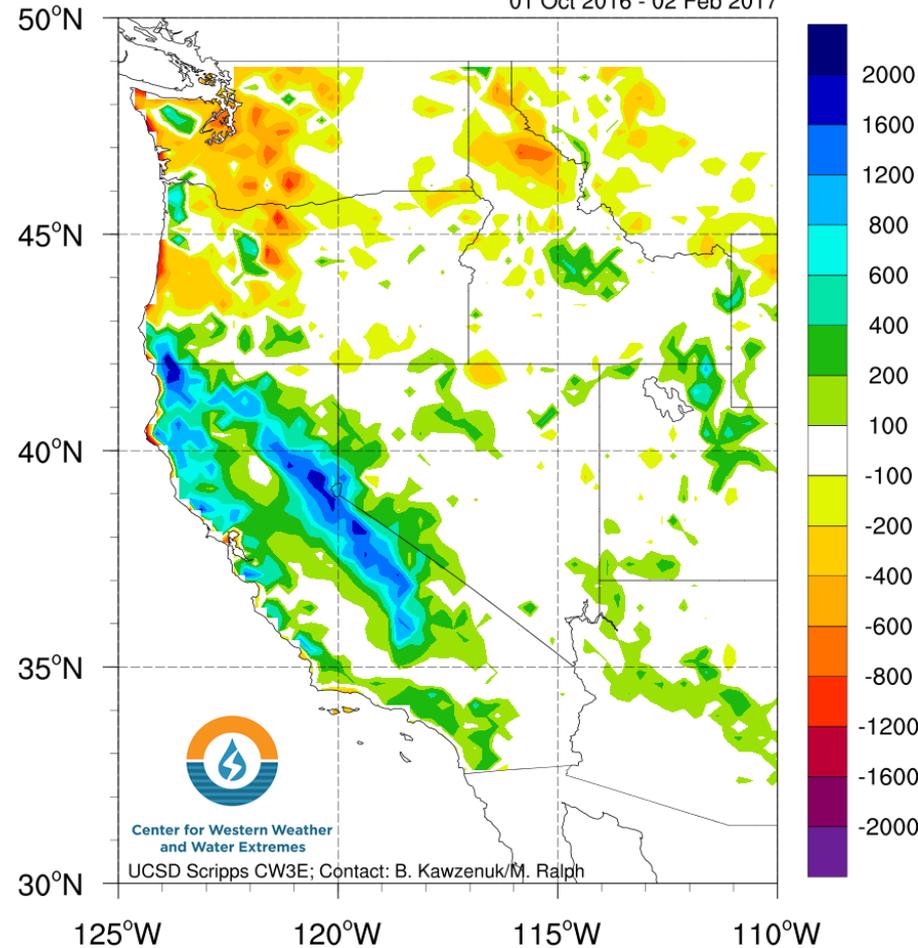
Total Water Year Precipitation (mm)

01 Oct 2016 - 02 Feb 2017



Water Year to Date Departure from Normal (mm)

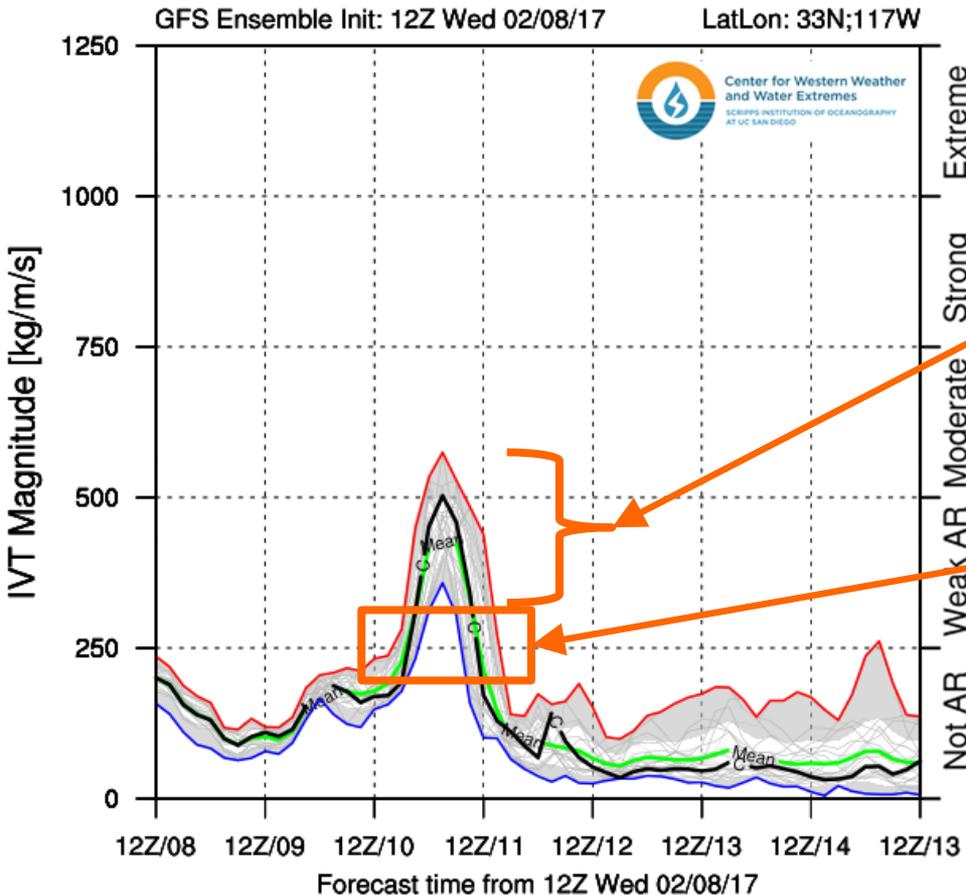
01 Oct 2016 - 02 Feb 2017



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# Plume Diagram for Oceanside, CA



- IVT Forecast for Oceanside, CA initialized at 4 AM 8 February 2017

**AR Conditions forecast for Friday 10 February**

- Maximum possible IVT       $\sim 550 \text{ kg m}^{-1} \text{ s}^{-1}$
- Mean IVT       $\sim 500 \text{ kg m}^{-1} \text{ s}^{-1}$
- Minimum possible IVT       $\sim 350 \text{ kg m}^{-1} \text{ s}^{-1}$
- Uncertainty       $\sim \pm 20\%$

- **Begin: 10 AM PST 10 February +/- 3 hrs**
- **End: 4 AM PST 11 February +/- 3 hrs**

